32.
TN707
.E8

ESSAY

ON THE

MANUFACTURE OF IRON,

WITH COKE.

A view of the cost of manufacturing iron on the Juniata Canal and Portage Rail Road, with Mineral Coal and Coke, according to the English method; embracing a comparative statement of the expense of making rail road and other iron, in Pennsylvania, near Hollidaysburg; and at Merthyr Tidville, in Wales, where a large portion of the rail road iron, used in the United States, is manufactured.

It is admitted by all persons who understand the subject, that the vast commercial and manufacturing superiority, that the English have obtained over the other nations of Europe, is mainly attributable to their immense manufactories of iron—far the greater part of which are located in Staffordshire, Glamorganshire; and the other counties bordering on the river Severn. The works in Glamorganshire, South Wales, are supposed to possess a small advantage over those of Staffordshire, in consequence of their vicinity to the Bristol Channel, and ship navigation.

The fuel that is used in the English iron works, is entirely mineral coal, similar in all respects to the boundless coal beds of the Allegheny mountain. The ore, of which the English iron that we see in the U. States, is made, is almost entirely the clay iron stone, of the coal beds, as it is termed by the miners; and is precisely the same kind of ore that is found in many places on the Allegheny mountain; but which is so

[1836].

8-36591

TN707
.E8

S207
E72

poor, that it has never been deemed of much value by the iron-masters of Pennsylvania, where there are boundless mines of brown hematite, brown argillaceous hydrate, and magnetic sparry iron ore—the latter being a very pure carbonate of iron.

In England and Wales, the beds of iron ore, lie in a horizontal position, generally under the seams of coal, and a few feet below them, in the same position, and of the same quality with those of the Allegheny mountain. The veins of ore are thin; and often so small, that no one would think of working them in the United States. They seldom exceed two feet or thirty inches in thickness; and are frequently worked, where they are not more than three inches in depth. In some instances, even a two inch vein, is followed for years.

This ore, when taken from the mine, does not contain more than *twenty, to twenty-five per cent*, of iron; but by burning, (roasting, as the English call it) pounding, washing, and riddling it, so much clay, slate, and other earthy matters, are separated from it, that when it is ready to be put into the furnace, the portion that is left, contains about *thirty-three per cent* of iron.

The expense of mining, and preparing the ore, ready to be put into the furnace, constitutes full two thirds of the whole cost of pig iron in England; as will be seen by the following table, taken from the rates of wages, paid to miners and other workmen, at the furnaces and mills, near Tidville, the largest establishment in the British dominions.

The price paid to miners, for mining ore, and putting it into small wagons, in the mines, varies from 8 to 14 shillings sterling, per ton —average, 11 shillings, or $2 64. It requires full four tons of this ore, as it comes from the hands of the miners, to yield one ton of pig iron, - - - -	10 56
Wages paid to girls, (girls work in the mines in England and Wales) who wheel the ore	

from the mine to the shaft, where it is raised from the mine, 3 pence—6 cents per ton for four tons - - - - - -	24
Cost of raising 4 tons of ore from the mine, up the shaft, generally done by steam power, is at least 10d. - - - . -	20
Expense of roasting, breaking, and riddling 4 tons ore, - - - -	50
Transporting 3 tons of ore from mine to furnace, (one ton being lost by roasting, &c.) say one mile, - - - - - -	50
Whole cost of ore sufficient to yield one ton of pig iron at Merthyr Tidville, *(Note 1.)*	$12 00
In addition to this, nearly a ton of limestone is used as a flux in smelting ore for a ton of pig iron; and this limestone must cost at least	50

The next item, is the coal, or fuel, for smelting. It requires on an average, a ton of coke, for each ton of ore that is smelted; or 3 tons of coke for each ton of pig. It requires two tons of coal to make one ton of coke—or 6 tons of coal for each ton of pig iron.

The cost of mining coal in Wales, varies from 6d. sterling, to 2s. 6d. per ton, according to the thickness and position of the vein:—average 18d. or 36 cents. The miner finding his own tools and light, as well in mining coal as ore.

Pay of miner for mining 6 tons coals, at 36 cts. per ton, - - - -		2 16
Pay to girls for wheeling away 6 tons of coal, and the expense of raising it from the mine, say - - ' - -		34
Cost of coking 6 tons of coal at 6d. per ton, say		50
Cost of steam to blow the furnace, $1,000 per year, - - -	$1,000	
Cost of the agent, clerk, and all		

the hands to work the furnace $2,000 yearly,	2,000	
Interest on capital, insurance, repairs &c.	2,000	
	$5,000	
If the furnace yields 3000 tons of pig iron yearly (a moderate estimate) the above items, making an aggregate of $5,000, will be per ton		1 67
Whole cost of one ton pig iron in Wales,		$17 17

In the above estimate, nothing is said of the immense expense which is incurred, in sinking shafts to reach the veins of coal and iron in England. Sums amounting to two or three hundred thousand pounds sterling, are sometimes disbursed, in the mere search for coal and iron ore. *(Note 2.)*

It may, with entire safety be assumed, that in Wales, the actual cost of a ton of pig iron will average more than $17 00; but supposing it to cost only that sum, let us see what is the cost of a ton of bar iron.

It requires 27 cwt. of pig to make a ton of bar iron, common size. 27 cwt. at 17 dollars per ton, is 22 dolls. 95 cts.—say		23 00
Cost of refining 27 cwt. of pig, is ½ ton coke,		50
Pay to refiner 4s 0d.—say		1 00
Puddling—1 ton coal,		50
Pay to puddler 10s. 6d.—say		2 50
Hammering into blooms,		1 00
Rolling—one ton coal,		50
Pay to roller—say		1 00
Cost of steam for rolling mill, yearly	$1,000	
Interest on capital and management	1,000	
Repairs and insurance	1,000	
	$3,000	

Or say one dollar per ton, on bar iron, 3000 tons being made yearly, *(Note 3.)*	1 00
	$31 00

It may be asserted, without danger of error, that 31 dols., or £6 10s sterling, is the lowest sum for which bar iron is, or can be made in England. It has sometimes been sold for less in that country, but never without loss to the manufacturer.

The above prices, except in two or three of the smallest items, have been taken from the rates of wages actually paid in South Wales. And these small items have been placed below their cost in Pennsylvania.

Immense beds of iron ore, one of which is one hundred feet in thickness, and of unknown extent downwards, are found at various points along the Juniata river, within a few hundred yards of the canal—several mines being within fifty miles of Hollidaysburg, by the route of the canal. These ores consist of brown hematite, brown argillaceous rock ore, and brown sparry magnetic ore, the latter a very pure carbonate of iron. Any of these ores, when burned, and prepared for the furnace, yield fifty per cent of cast iron. *(Note 4.)*

The Portage Rail Road, within fifteen miles of Hollidaysburg, passes through and over interminable fields of as good bituminous coal, as is found in the world. This coal only requires skillful mining, to be unsurpassed.

The cost of manufacturing a ton of bar iron, by placing one furnace, and the necessary puddling and rolling establishments, at the side of the portage road, in the coal fields; and another furnace near the iron mines, beside the Juniata canal, so that the boats could go up loaded with ore, and return loaded with coke, would be nearly as follows. The ore being free from clay, and other foreign matter, and as easily to be mined as sand stone is to be taken from a quarry.

Two and a half tons of this ore, as it is raised from the mine, will yield a ton of pig iron.

Mining 2½ tons of ore, at 25 cts. per ton, say	$00 75
Transporting 2½ tons of ore, half a mile to canal, on rail road, of wooden rails,	00 75
Roasting 2½ tons of ore, at canal,	00 50

This 2½ tons when roasted, will be reduced to two tons, by the loss of its moisture.

Cost of transporting two tons of ore to Hollidaysburg, in a boat of 50 tons, 50 miles distance by the canal. The ore being placed in boxes, containing one ton and a half each, to be hoisted into and out of the boat by cranes, the boxes made so that two of them will form the body or box of one rail road car, as is now done by one company that transports goods from Philadelphia to Pittsburg. In this way the expense of handling the ore at Hollidaysburg, will be saved. The ore being removed from the boxes only at the furnace,	1 00
Toll on canal, on two tons of ore, 50 miles, at 6 mills per ton,	00 60
Cost of transporting two tons of ore, including tolls, from Hollidaysburg to the furnace in the coal fields, by rail road, 90 cts., say	1 00

This ore being mined in a limestone country, does not require so much lime to flux it, as the English ore does, the latter being mined where no lime exists.

500 pounds of limestone will be sufficient per ton,	00 25

Two tons of coke will be sufficient to smelt two tons of ore, which will yield one ton of pig iron. This is known in two ways—1st, in England a ton of coke is sufficient to smelt a ton of their ore, which is poorer, lighter, and consequently possesses more bulk of matter to be smelted than the Juniata ore. 2nd, 200 bushels of charcoal is amply sufficient, for the production of a ton of pig iron from this ore, as is proved by actual experience. 100 bushels of coke, is equal to one hundred and fifty bushels of common oak and pine charcoal; such as is used in the charcoal furnaces. A bushel of coke weighs 32 pounds, and a bushel of oak and pine mixed charcoal, 16 pounds. Coke is equál to five-sixths of its weight of charcoal, in the production of heat.

To make two tons of coke takes four tons of coal, the mining of which will cost, at one cent per bushel, (30 bushels to the ton,) the price paid at Pittsburg, $1 25, say		1 50
Coking four tons of coal into two of coke,		00 50
To transport two tons of coke to furnace, half a mile by wooden rail road,		00 50
Cost of steam power, by the year, for furnace, $1,500—fifty per cent higher than in England,	$1,500	
Cost of manager, clerks, and the hands to work the furnace—fifty per cent higher than in England,	3,000	
Interest on capital, repairs, insurance, &c.—fifty per cent higher than in England,	3,000	
	$7,500	
Supposing the furnace to yield 3000 tons yearly, ($7,500) will be on each ton,		2 50
		$9 85
Whole cost of one ton of pig iron, made with coke, of Juniata ore, say		$10 00

Cost of one ton common Bar Iron will be as follows, Pittsburg prices.

2,700 lbs. of pig, is required for one ton bar,	$13 50
They pay at Pittsburg for refining metal, for 1 ton bar,	1 00

This requires 30 bushels coke, cost at Portage, 65 cts. say		00 75
They pay at Pittsburg for puddling, per ton, of bar,		3 00
Requires one ton coal, cost at Portage,		00 50
They pay at Pittsburg, for hammering 1 ton blooms, no coal required,		1 00
They pay at Pittsburg for rolling one ton,		1 50
Requires one ton coal,		00 50
Cost of steam for rolling mill per annum—fifty per cent higher than in England,	$1,500	
Interest on capital and management—fifty per cent higher than in England,	1,500	
Repairs and insurance per year—fifty per cent higher than in England,	1,500	
	$4,500	
Or $1 50 on each ton of bar iron, 3000 tons being made yearly, say		1 50
Total,		$23 25

From the preceding tables it is manifest that bar iron can be made with coke, cheaper, by $8 per ton, in Pennsylvania than it is, or can be in England. The main, and indeed the only cause, of this great difference in favour of American iron, is founded in the superiority of the ore of Pennsylvania, over that of England, together with the trifling expense of mining it. Ore in endless quantities, is contained in the mines, along the Juniata river, almost on the margin of the canal, in locations as favourable as represented in this paper. Iron can be made from these mines to supply the United States for ages.

At the present rate of tolls on the canals and rail roads, it would cost about eight dollars to transport a ton of bar iron from the Portage to Philadelphia. So that American iron could be made and delivered in Philadelphia, as cheap as the English iron can be furnished at their works.

Rail road iron could be made at the Portage, and delivered in any part of the Atlantic States, at ten dollars per ton cheaper than the same iron could be brought from England, to the same point, without any protective duty in favour of the American manufacture.

In the above comparative tables, the cost of steam power, interest, insurance, repairs, superintendence, price of labour at the furnace, and all other expenses, not established by usage in the two countries, are charged 50 per cent higher in Pennsylvania than in England.

With the aid of competent skill and capital, iron can doubtlessly be made at less expense, on the Juniata Canal and Portage Rail Road, than at any other place in either Europe or America. *(Note 5.)*

Note 1.—In some cases the ore is raised from the mine, within a few rods of the furnace; but in others it is brought from the mine to the furnace, a distance of two or three miles, on rail roads. The ores of Cornwall and Devonshire, are carried to Wales to be smelted; and extensive iron works, near Sheffield, in the South of Yorkshire, are supplied with ore from the county of Cumberland, by the course of the transportation, nearly 200 miles—partly by sea, partly by canal, and partly by rail road.

The furnaces, forges, and rolling mills are generally placed near the coal mines.

Note 2.—Few persons in the United States have any knowledge of the vast sums of money that are expended in the various operations of mining in England and Wales.

In many of the mines of Cornwall, the ores are raised from a depth of more than 1200 feet; and in one instance, a tunnel, or *adit*, as the miners call it, has been cut a distance of twenty-four miles, under ground, to drain the water from the mines.

A company now, or lately operating in South

Wales, has expended $1,500,000 in quest of coal, without, at the last advices, having obtained the object of their search.

Note 3.—The selling price of iron has varied greatly in England, within the last 30 years. In 1806 common bar iron sold for £20, whilst in 1830, it was as low as £6. In 1835 it was £7; and at this time, in consequence of the great demand for rail road iron in the United States, common bar iron is worth £9 10 sterling at the works in Wales.

It is the opinion of workmen of the greatest experience, who have passed their lives at the iron works in Wales and Staffordshire, that in the most favourable situations bar iron cannot be made for less than £6 10s; and when the price is below that, at the works, the proprietors must suffer loss. Some of the British furnaces yield 100 tons by the week, or 5000 yearly.

Note 4.—The ore along the Juniata river, is, with very few exceptions, found embeded in the transition formation of the country—often supported by lime, and overlaid by slate. Great masses of hydrate of iron are found unconnected with lime. The carbonate of iron is always found in beds, more or less inclined to the plane of the horizon. One of these beds is full 100 feet in thickness, nearly a mile in length, and dips to the south east, at an angle of forty degrees. This ore, when cut with a file, shines like pure metal.

In 1830, the iron trade was greatly depressed, and many of the manufacturers suffered heavy losses, in consequence of which numerous failures took place. In that year, pig iron was sold in Wales as low as £3 5s., or $15 60 cts, which was admitted to be below the cost of the article. For some time before the late great rise in the price of iron, to meet the demand in the United States, say for the last three years, the price of common bar iron had averaged about £7 sterling, or $33 60, at the works; and pig iron averaged about £3 17s. 6d. sterling, or 18 dols. 60 cts., at the works: affording a profit of about 1 dol. 50 cts. on each ton of pigs, and about 2 dols. 50 cts. on each ton of bar iron. These profits may appear small at first, but when we reflect that one of these large English furnaces yields 5000 tons of pig iron yearly, and that bar iron is made with proportionate rapidity, in the puddling furnaces and rolling mills, we comprehend how it is that the English iron masters can become weathy by selling iron at a profit of five shillings a ton.

At one place in South Wales, there are thirteen blast furnaces, and the necessary puddling furnaces and rolling mills, to convert the pig into bar iron. At this establishment more than a hundred tons of bars is made every day, and at the present prices of iron in England, £9 10s., the profits must be at least 1250 dols. daily.

Note 5.—At this moment, the various rail roads which are actually in progress of being made, or that are intended to be made, within a short time, are equal in length to a straight line of five thousand miles. If these roads are laid with double tracks of rails, each mile will require at least 250 tons of iron, 220 tons of which will be in rails, and the residue in chairs, bolts, &c.

This iron, if imported, will cost at New York, at least $60 per ton, unless the prices fall greatly in Europe.

5000 multiplied by 250, is 1,250,000 dols.; this again by 60, is 75,000,000 dols. that will be paid in the United States for foreign rail road iron, within five years to come.

In addition to this, we have for several years past, imported yearly 100,000 tons of iron, of the value of more than 8,000,000 dols., per annum, in Europe; to which is to be added the cost of the importation, mercantile profits, and duties to our own government.

In many of the iron manufactories of England, more than a million of dollars is vested in a single establishment. Few individuals, in the United States, are able to enter into fair competition with the great British capitalists.

Successful experiments have lately been tried, in Pennsylvania, in making pig iron with coke. In some parts of the Allegheny mountain, considerable beds of brown argillaceous iron ore are found, sometimes in veins called shell ore, and sometimes in amorphous masses, embeded in strata of clay. This is the same kind of ore with the clay iron stone of the English coal beds. These veins vary from two or three inches, to two or three feet in thickness. The ore when burned, and prepared for the furnace, has lost one third of its weight as it came from the mine, and yields 30 to 35 per cent of cast iron. 350 bushels of oak and pine charcoal, equal to full 3 tons of coke, is consumed in producing one ton of pig. With this ore, iron can probably be made as cheap, in those parts of the Allegheny mountain, where provisions and other supplies can be conveniently procured, as it can be in Wales, unless the higher price of labour, in Pennsylvania, may make a difference in the cost.

But far the most abundant ore of the Allegheny coal fields, is the grey iron balls, or kidney ore, as the miners call it. Numerous veins of this ore, imbeded in strata of clay, are found on Tioga river, the West Branch of the Susquehannah, and round the heads of the Potomack. It is seen in all the western counties of Pennsylvania, but is expensive to mine, and so difficult to be reduced in the furnace, that five hundred bushels of oak and chesnut charcoal is consumed in producing one ton of pig, from 3 tons of the prepared ore. This is equal to five tons of coke. At the Clyde iron works in Scotland, where the kidney ore is used alone, six tons of coke, is consumed in the production of one ton of pig.

Lewistown, Pa. April, 1836.

J. W. SHUGERT, Printer, Lewistown.

Isaac Fi